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ANNUAL REPORT OF PROGRESS, 1964 - 1965

FEDERAL AID IN FISH RESTORATION PROJECT F-5-R-6

SPORT FISH INVESTIGATIONS OF ALASKA

ALASKA DEPARTMENT OF FISH AND GAME
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INTRODUCTION

This report of progress consists of Job Segment Reports from the State of Alaska Federal Aid in Fish Restoration Project F-5-R-6, "Sport Fish Investigations of Alaska."

The project during this report period is composed of 23 separate studies designed to evaluate the various aspects of the State's recreational fishery resources. Of these, eight jobs are designed to pursue the cataloging and inventory of the numerous State waters in an attempt to index the potential recreational fisheries. Four jobs are designed for collection of specific sport fisheries creel census while the remainder of the jobs are more specific in nature. These include independent studies on king salmon, silver salmon, grayling, Dolly Varden, a statewide access evaluation program and an egg take program.

A report concerning the residual effects of toxaphene accumulates the findings of a three-year study. The report presented here terminates this segment and is a final report. The information gathered from the combined studies will provide the necessary background data for a better understanding of local management problems and will assist in the development of future investigational studies.

The subject matter contained within these reports is often fragmentary in nature. The findings may not be conclusive and the interpretations contained therein are subject to re-evaluation as the work progresses.

JOB COMPLETION REPORT

RESEARCH PROJECT SEGMENT

STATE: ALASKA Name: Sport Fish Investigations of Alaska.

Project No.: F-5-R-6 Title: Silver Salmon Studies in the Resurrection Bay Area.

Job No.: 7-B-1

Period Covered: July 1, 1964 to June 30, 1965.

ABSTRACT

A creel census conducted in the area of the former small boat harbor showed that an estimated 2,971 silver salmon and 838 pink salmon were taken during 7,540 man-days of effort. The commercial catch consisted of 656 silver salmon and 247 pink salmon. The total silver salmon escapement for eight index streams was 2,087. The ratio of males to females in these streams ranged from 1.9:1 to 0.8:1. The catch-to-escapement ratio for marked silver salmon in Resurrection Bay was 0.4:1.

The barrier at the outlet of rehabilitated Bear Lake was destroyed as a result of the Good Friday earthquake and reinfestation of the lake by Dolly Varden and threespine sticklebacks occurred. A concrete weir to assess upstream and downstream salmon migrations and to serve as a permanent barrier was completed in Bear Creek on August 25.

An estimated 8,496 marked (AD-LV) downstream migrant silver salmon were captured in Bear Creek from April 9 to October 31. These fish are from a plant of 148,057 fry made in November-December of 1963 after Bear Lake detoxified. The peak of the out-migration occurred on June 22 and the mean fork length of the smolts was 95.4 mm. From September 5 to November 9, 953 adult silver salmon were captured at the Bear Creek weir; 46 percent of these fish were marked during the 1963 smolt seaward migration. The survival of marked smolts to returning adults at the weir was 6.13 percent.

Information is presented on Inlet No. 3 of Bear Lake which is being evaluated as a water supply for a possible artificial spawning channel for silver salmon.

Detailed information collected for this project is available at the Seward Field Office.

RECOMMENDATIONS

1. Retain the present objectives of the study.
2. Determine the rate of stickleback reinfestation in rehabilitated Bear Lake.
3. Determine the limnology, species composition, relative abundance and growth of fishes in the Seward Lagoon with major emphasis on silver salmon.

OBJECTIVES

To collect and analyze biological data concerning the distribution, abundance and timing of adult and juvenile silver salmon in the Resurrection Bay area.

To determine the age composition of these adult and juvenile silver salmon.

To determine the sport and commercial harvest of silver salmon in Resurrection Bay and determine the natural and fishing mortality in salt water.

To investigate the environmental limitations of the juvenile silver salmon in this system and provide recommendations for management practices.

To determine the methods and means of increasing or extending the freshwater spawning and rearing areas of the watershed and mitigating freshwater mortality.

To provide recommendations for the management of silver salmon in these waters and direct the course of future studies.

TECHNIQUES USED

Silver salmon sport harvest and effort in Resurrection Bay was determined by creel census. Because the small boat harbor was destroyed by seismic sea waves resulting from the March 27 earthquake, a sampling plan different from those used in past years was initiated. Boats could be contacted at temporary launching ramps constructed at the following locations: (1) the former small boat harbor, (2) the Army Recreation Camp and (3) Lowell Point. The majority of anglers utilized the small boat harbor ramp. A Latin square sampling schedule with four 3.5-hour periods extending from 0800 to 2200 hours was employed at the small boat harbor area. No sampling was done before 0800 hours because past creel census data showed very few anglers completed fishing before this time. Two periods were sampled daily on all weekends, holidays and three of the five weekdays. During a census period only those boats which had completed fishing were enumerated. All days were censused

during the Seward Silver Salmon Derby. Army personnel kept a record of boats using the ramp at the Army Recreation Center and the owner of the boat rental at Lowell Point recorded the number of boats using that area. The harvest was determined by interviewing as many fishermen as possible at the former small boat harbor site with the following questions asked: (1) number of anglers per boat, (2) number of silver and pink salmon caught and (3) total hours fished. Silver salmon were examined whenever possible for past fin clips.

Silver salmon escapement was determined by conducting weekly foot surveys on seven major silver salmon streams. Salmon carcasses were sexed, then mutilated to prevent recounting on subsequent surveys. A concrete weir constructed in Bear Creek during 1964 was in operation for the entire silver salmon upstream migration. Abundance and timing of downstream migrant silver salmon from Bear Lake was determined by periodical sampling with fyke nets and by using a modified Wolf-trap on the old weir.

Silver salmon lengths, weights and scale samples were collected from the sport catch in Resurrection Bay and at the new Bear Creek weir. Age determinations were made using a micro-projector after the scales had been impressed on 0.02-inch-thick cellulose acetate.

FINDINGS

A description of the Resurrection Bay area and past information collected on this project is presented in reports by Dunn (1961) and Logan (1962, 1963, 1964).

Silver Salmon Harvest and Effort

A creel census to determine the sport harvest, effort and rate of exploitation of silver salmon in Resurrection Bay was conducted from July 18 to September 11, 1964. The total sport harvest was estimated at 2,971 silver salmon and 838 pink salmon. This estimate was based on interviews with 1,818 anglers which had taken 720 silver and 189 pink salmon. This year's catch was the lowest recorded since the census was initiated in 1961 (Table 1). The peak of the harvest occurred during the nine-day Seward Silver Salmon Derby (August 8-16). An estimated 1,070 silver salmon (36 percent) were taken during the Derby.

TABLE 1. - Sport and Commercial Harvests of Silver Salmon in Resurrection Bay, 1961-1964

<u>Year</u>	<u>Sport Harvest</u>	<u>Commercial Harvest</u>	<u>Total Harvest</u>
1961	5,504	1,332*	6,836
1962	14,482	3,923	18,405
1963	7,293	2,250	9,543
1964	2,971	656**	3,627

* Report by cannery operator but not recorded on fish tickets.

** An estimated 650 fish were caught by a Seward purse seiner but not recorded on fish tickets.

The commercial harvest in Resurrection Bay (statistical area 231-30) based on cannery fish tickets was 6 silver salmon and 247 pink salmon. A Seward purse seiner reported taking an estimated 650 silver salmon which he was unable to market. The minor commercial effort is due to the canneries and most of the fishing boats being destroyed by the March 27 seismic sea waves. The commercial catch from 1961 to 1964 shown in Table 1 has comprised from 18.1 to 23.6 percent of the total harvest. The reported subsistence catch, based on the return of five of seven permits issued, was 8 silver salmon, 1 red salmon and 33 chum salmon.

The total sport effort was estimated at 7,540 man-days with 24.1 percent of the anglers being contacted. The total number of boat trips was estimated at 2,682. This year's effort was less than half of that expended in 1963 (Table 2). This was because the highway between Anchorage and Seward was in poor condition due to earthquake damage. There was also a lack of good boat moorage facilities at Seward. An estimated 4,150 man-days of effort (55 percent) occurred during the Derby. The number of tickets sold and the duration of the Derbies from 1956 to 1964 is shown in Table 3. Military personnel fishing from boats provided by the Army Recreation Camp in Seward accounted for 1,809 man-days of effort (24 percent). The silver salmon catch per hour of 0.06 was the lowest recorded (Table 2). The catch per hour for pink salmon was 0.02. The mean number of fishermen per boat was 2.7 and the average angler fished 6.2 hours per trip.

Male silver salmon taken in the sport fishery averaged 681 mm and 10.3 lbs. while females averaged 673 mm and 9.8 lbs. The ratio of males to females was 1.3:1. Fork lengths, weights and sex ratios for silver salmon sampled from 1960 to 1964 are presented in Table 4.

TABLE 2. - Silver Salmon Sport Effort, Catch Per Hour and Period of Census in Resurrection Bay, 1961-1964

<u>Year</u>	<u>Total Effort (Man-Days)</u>	<u>Derby Effort (Man-Days)</u>	<u>Catch Per Hour</u>	<u>Period of Census</u>
1961	6,002	2,870	0.10	7/11-9/ 9
1962	11,380	5,435	0.17	7/ 7-9/ 7
1963	15,430	7,480	0.07	7/17-9/10
1964	7,540	4,150	0.06	7/18-9/11

TABLE 3. - Number of Tickets Sold and Length in Days for the Seward Silver Salmon Derby, 1956-1964

<u>Year</u>	<u>Number of Tickets</u>	<u>Number of Days</u>
1956	1,100	4
1957	1,400	4
1958	1,562	4
1959	2,273	4
1960	1,700	10
1961	2,200	4
1962	2,400	4
1963	2,625	5
1964	2,104	9

TABLE 4. - Fork Lengths, Weights and Sex Ratios of Silver Salmon from Resurrection Bay, 1960-1964

Year	Males*					Females					Sex
	Length (mm.)		Weight (lbs.)		No.	Length (mm.)		Weight (lbs.)		No.	Ratio
	Mean	Range	Mean	Range		Mean	Range	Mean	Range		♂/♀
1960	661	780-500	9.0	19.5-3.3	129	654	735-545	8.4	12.8-5.0	79	1.6:1
1961	681	775-545	9.4	13.9-4.6	41	671	720-585	9.1	11.4-5.1	39	1.0:1
1962	664	750-545	8.9	14.1-4.5	74	663	760-545	8.8	12.5-4.5	56	1.3:1
1963	677	830-505			359	699	785-515			309	1.2:1
1964	681	790-535	10.3	14.8-5.0	111	673	740-570	9.8	14.0-6.4	86	1.3:1

* Precocious males "jacks" which are uncommon in this are not included.

Silver Salmon Escapement

Since 1961, seven of the most important silver salmon streams that can accurately be enumerated by foot have been surveyed to provide an escapement index. Counts made at the Bear Creek weir will be discussed later. The Resurrection River, probably the greatest silver salmon producer in the area, was not surveyed because its glacial water and size precluded direct methods of enumeration. This year's total count of 2,087 silver salmon for all index streams was slightly higher than the mean of 1,778 for the past three years. The minimum escapement for each index stream and Bear Creek from 1961 to 1964 is shown in Table 5. The greatest escapements observed since the initiation of the project occurred in Clear Creek, Grouse Creek, Jap Creek and Mayor Creek during 1964. As in previous years, a significant number of fish (26.5 percent) were killed in Dairy Creek by children before they were able to spawn.

TABLE 5. - Minimum Silver Salmon Escapements for Eight Index Streams in the Resurrection Bay Area, 1961-1964

Name of Stream	Date Fish First Observed	Minimum Escapements			
		1964	1963	1962	1961
Airport Creek	8/28	52	42	55	162
Bear Creek	8/21	953	258	1,484	972
Clear Creek	9/22	217	40	78	96
Dairy Creek	9/21	245	188	603	249
Grouse Creek	9/23	294	76	210	24
Jap Creek	9/24	152	72	92	91
Mayor Creek	9/24	95	15	30	21
Salmon Creek	*	79	175	212	90
TOTAL		2,087	866	2,764	1,705

* Surveys were not initiated until after 10/30 to preclude enumerating Bear or Grouse Creek fish.

Sex ratios for all index streams, determined by examination of silver salmon carcasses, from 1961 to 1964 are presented in Table 6. From this data it is apparent that there is a wide divergence in sex ratios between streams and even within the same stream with males generally being the most abundant. The highest ratio of males occurred in Bear Creek (1.9:1) and the lowest ratio in Bear, Clear and Dairy Creeks (0.8:1).

TABLE 6. - Ratio of Male to Female Silver Salmon in Eight Index Streams in the Resurrection Bay Area, 1961-1964 (Number of Fish Examined in Parentheses)

Name of Stream	Year			
	1964	1963	1962	1961
Airport Creek	1.2:1 (11)	1.1:1 (32)	1.2:1 (38)	1.1:1 (58)
Bear Creek	1.9:1 (909)	0.8:1 (67)	1.1:1 (1259)	1.6:1 (224)
Clear Creek	1.4:1 (39)	1.0:1 (29)	1.1:1 (47)	0.8:1 (7)
Dairy Creek	0.8:1 (208)	1.2:1 (69)	1.0:1 (593)	1.7:1 (229)
Grouse Creek	1.5:1 (70)	1.3:1 (39)	1.1:1 (70)	*
Jap Creek	1.2:1 (107)	1.0:1 (41)	0.9:1 (52)	1.0:1 (38)
Mayor Creek	0.9:1 (27)	*	*	*
Salmon Creek	1.0:1 (10)	1.0:1 (45)	0.9:1 (94)	1.0:1 (10)

* Sample too small.

Seward Lagoon

The brackish water of Seward Lagoon, at the outlet of Dairy Creek, has been an excellent rearing area for juvenile salmon. The March 27 earthquake and subsequent seismic sea waves destroyed the tide gates which controlled the salinity in the lagoon with the result that it has become nearly pure sea water. Because high salinities could be expected to be deleterious to silver salmon fry, an effort was made to salvage part of the run by artificially spawning silver salmon dip-netted from Dairy Creek. A total of 52 females were spawned which yielded an estimated 216,878 eggs (Engel, 1964). The mean number of eggs per female was 4,171. The fork length of the females spawned ranged from 665 to 790 mm with a mean of 728. Fish will be allowed to spawn naturally when a tide gate structure planned by the Corps of Engineers is completed in 1965.

Bear Lake System

The Bear Lake system was selected for intensive study because it is an important silver salmon producing area. In an attempt to increase its potential for rearing juvenile silver salmon, Bear Lake was rehabilitated with rotenone on August 6, 1963, to eliminate competitor and predator fishes (Dolly Varden, threespine sticklebacks and sculpins). After the lake was detoxified it was restocked with 148,057 clipped (AD-LV) young-of-the-year silver salmon between November 13 and December 8, 1963. A temporary barrier dam was constructed at the outlet of Bear Lake to prevent the ingress of all fish species. Salmon were trapped below the barrier and moved to the lake. A concrete weir was planned for completion by May 15, 1964, to provide a permanent barrier and to allow assessment of upstream and downstream migrations. The Good Friday earthquake damaged the temporary barrier dam and on May 25, 1964, it washed out during a period of heavy rains. This washout allowed unobstructed entry of all fish into the lake. The barrier was repaired by June 15 and the stream was dewatered for five days to facilitate the contractor's construction of the new weir. Since facilities were not yet available to pass adult red salmon into the lake, a temporary fish ladder with two pools was built below the barrier. A rise of 2.5 feet at the first pool prevented passage of sticklebacks into the lake. Concomitant with the end of the red salmon run, the early part of the Dolly Varden migration was also able to enter the lake. It is expected, however, that nearly all of the Dolly Varden will migrate out of the lake during the spring of 1965.

The weir, located 1,750 feet downstream from the outlet of the lake, was completed on August 25 (100 days behind its planned completion date).

Silver Salmon Downstream Migration

To determine the abundance and timing of planted juvenile silver salmon migrating seaward from Bear Lake, sampling was conducted in Bear Creek from April 9 to October 31. From April 9 to June 20, two fyke nets covering approximately 50 percent of the stream were fished on alternate nights from 1700 to 0900 hours. A Wolf-trap was later used for sampling during 27 24-hour periods. These samples showed that 16.0 percent of the fish were missed between 0900 and 1700 hours. Smolt estimates were determined by averaging the counts preceding and following each daily gap and multiplying by the time and section of stream sampled factor. From June 20 to August 11 the Wolf-trap was in operation on the old weir, providing a total count of all downstream migrants. The trap was removed on August 12 because of high stream flows and shortage of personnel. The fishpass model "B," used for

trapping all downstream migrants, was in operation on the new weir from September 1 to October 31.

Marked silver salmon smolts were captured the first time the fyke nets were fished (April 9). In 1963 and 1962 the first smolt was not captured until May 21 and 25, respectively, which was shortly after the ice breakup on Bear Lake. The 1964 breakup did not occur until June 8. Why these partially hatchery-reared fish initiated out-migration earlier than those in natural populations is not known at this time.

An estimated 8,496 silver salmon smolts (AD-LV clip) from the 1963 plant migrated from Bear Lake from April 9 to October 31; 831 (9.8 percent) of these fish were found dead. Mortality resulted from the following causes: stream dewatering for weir construction, 588; injury from fyke nets, 114; injury from Wolf-trap, 128 and injury from fishpass model "B," 1. Table 7 presents out-migration of silver salmon smolts, water temperatures and stream flows in Bear Creek by monthly periods. The greatest number of smolts captured on any single day was 4,128 (48.6 percent of the total) on June 22. The peak day of the 1963 and 1962 smolt out-migration was June 7 when 19.6 and 14.6 percent, respectively, of the total run was captured.

An estimated 43,000 silver salmon fry (168 per pound) marked with an adipose and right pelvic clip were planted in Bear Lake on September 16. These fish are from egg takes conducted at the Swanson River on the Kenai Peninsula and from a stream near Ketchikan in Southeastern Alaska. The first fish from this plant was captured at the Bear Creek weir on September 17 with 147 being counted until the trap was closed on October 31 (Table 7).

During the period the smolt migration was sampled, natural stream flows, excluding floods caused by dams washing out or stream dewatering, ranged from 8.0 to 31.4 cfs. The water temperature at the initiation of sampling was 32° F., reached a high of 63° F. on August 6 and dropped to 38° F. on October 31 when sampling was terminated.

The fork length of the 718 downstream migrants (AD-LV) that were measured ranged from 62 to 214 mm. The mean fork length during the peak of migration (June 22) was 95.4 mm. This is considerably less than the mean of 114.6 and 115.0 mm for smolts during the peak of the 1962 and 1963 migrations, respectively. All fish comprising the present out-migration were planted in Bear Lake from November 13 to December 8, 1963, at a mean fork length of 81 mm (88 per pound). The increase in size from time of stocking to the peak of migration was 14.4 mm. The size of silver salmon smolts collected periodically during the out-migration is shown in Table 8. From this

TABLE 7. - Monthly Silver Salmon Downstream Migrations, Water Temperatures and Stream Flows at Bear Creek, 1964

Month	Silver Salmon		Water Temperatures (°F.)		Water Flows (cfs)*	
	1963 Plant	1964 Plant	Mean	Range	Mean	Range
	(AD-LV)	(AD-RV)				
April	95		33.0	32-34	9.1	8.0-10.2
May	334		34.4	33-37	12.0	8.0-17.0
June	6,742		44.8	38-53	17.3	9.4-21.0
July	826		56.2	52-60	13.1	10.3-19.7
Aug.	162		57.7	51-63	11.6	9.1-20.9
Sept.	170	68	52.3	43-59	23.1	13.8-31.4
Oct.	<u>167</u>	<u>79</u>	42.5	38-51	18.0	14.1-26.7
TOTAL	8,496	147				

* Unnatural stream flows resulting from the dam washout or stream dewatering are not included.

it is apparent that little growth occurred prior to May and after September.

TABLE 8. - Fork Lengths in Millimeters of Silver Salmon Smolt (AD-LV) Collected During Different Periods From Bear Creek, 1964

<u>Period</u>	<u>Mean</u>	<u>Range</u>	<u>Number</u>
4/12- 4/22	79.4	68- 96	22
5/ 2- 5/12	83.0	65-102	26
5/17- 5/23	84.7	62- 99	48
5/31- 6/ 9	89.0	65-111	26
6/14- 6/18	95.1	83-103	51
6/26- 6/27	95.6	82-128	83
7/17- 7/27	124.9	87-146	72
7/29- 8/ 9	131.9	72-172	103
9/21- 9/27	143.3	99-214	145
10/ 1-10/10	140.0	111-214	71
10/13-10/20	139.7	106-170	42
10/23-10/29	138.4	117-163	29

Although the average smolt size during the 1964 migration peak was smaller than past years, all fish were Age I. Age composition of the 1962 and 1963 samples were as follows: Age I, 20.9 and 27.3 percent; Age II, 68.7 and 70.9 percent; Age III, 10.4 and 1.8 percent, respectively. The gradually increasing smolt size of the small number of 1964 migrants captured after June (Table 7) to a mean of approximately 139 mm in October does not exclude the possibility of a segment of the population becoming "landlocked." This has been noted for stocked silver salmon in other areas although it is usually related to small outlet flows.

Silver salmon fry were first collected at the weir on July 16. In 1962 and 1963 they were first observed on July 8 and 15, respectively. Although no quantitative measurement of their abundance can be made, it does not appear great. A total of 235 was captured in the Wolf-trap between July 16 and August 11. None were taken after September 1 when the new weir was in operation upstream.

During September a large school of juvenile silver salmon were observed attempting to migrate upstream past the new weir. A total of 1,768 of these fish was seined below the weir on September 6 and passed upstream. Before the downstream trap was closed, 156 were recaptured. One hundred fish were measured having fork lengths ranging from 57 to 95 mm with a mean of 74.5. Scales from 47 of these fish showed them to be young-of-the-year (Age 0). Production in this system could be affected considerably if a large number of fry are produced in

Bear Creek below the weir or if they drift downstream from Bear Lake and are unable to return upstream to rear in the lake because of the weir. This type of migration is common for red salmon fry which are produced below a lake system and must wait until they are of a sufficient size to swim upstream.

Silver Salmon Upstream Migration

The first adult silver salmon was not captured at the new weir until September 5, although the weir was a barrier to upstream migrants on August 27. Their timing by biweekly periods is shown in Table 9. A total of 953 adults had been enumerated when the weir was closed on November 9. The peak of the migration occurred on September 25, when 122 fish (12.8 percent of the total run) were counted. The early part of the migration consisted predominantly of males with the sex ratio becoming equal in early October and slightly in favor of females from that time on (Table 9). The ratio of males to females for the entire run was 1.9:1.

TABLE 9. - Biweekly Upstream Weir Counts and Sex Ratios of Male and Female Adult Silver Salmon in Bear Creek, 1964

<u>Biweekly Periods</u>	<u>Males</u>	<u>Females</u>	<u>Total</u>	<u>Sex Ratio</u>
9/ 5- 9/15	36	10	90*	3.6:1
9/16- 9/30	435	179	614	2.4:1
10/ 1-10/15	105	106	211	1.0:1
10/16-10/31	12	15	27	0.8:1
11/ 1-11/ 9	<u>5</u>	<u>6</u>	<u>11</u>	<u>0.8:1</u>
TOTAL	593	316	953	1.9:1

* Forty-four fish were not sexed during this period.

The water temperature at the initiation of migration was 58° F. (September 5), and gradually declined to 36° F. at the end of migration (November 9). Natural stream flows during this period ranged from 13.8 to 31.4 cfs.

Foot surveys were conducted on Bear Creek and the inlets of Bear Lake to note the distribution of spawning fish. A survey conducted on November 9, after the weir was closed for the season, showed that 33 silver salmon were still in Bear Creek. The inlets of Bear Lake, foot-surveyed from October 22 to November 11, had the following escapements: Inlet No. 1 - 0; Inlet No. 2 - 0 and Inlet No. 3 - 54. A school comprising approximately 200 fish was observed off the mouth of Inlet No. 1.

This is a major beach spawning area for red salmon. Twenty fish were estimated to be in the lake off Inlet No. 2, but none were seen off Inlet No. 3. Silver salmon are generally considered stream spawners; however, they may spawn extensively in Bear Lake. Of the 953 fish passed over the weir, less than 6 percent were observed in the lake's inlets which are small and easy to survey. Spawning in the 1,750-foot section of stream between the weir and the lake is unlikely due to heavy deposits of silt and sawdust.

Upstream Migration - Other Species

The red salmon upstream migration had been in progress at least a month when the old weir was installed on June 20. From that time until the weir was removed on August 11, 3,099 red salmon were counted. The first pink salmon was captured on July 14 and 6,559 were counted by August 11. The first Dolly Varden was enumerated on July 9 with 263 being counted by August 11. It is not known how many Dolly Varden moved into the lake between August 11 and 27 when a permanent barrier was established. Two years of past migration data showed that from 146 to 843 fish had moved into Bear Lake during this period.

Recovery of Marked Silver Salmon

During the out-migration of 1963, 7,111 silver salmon smolts were marked with an adipose and left ventral clip. These fish were expected to return as adults in the summer and fall of 1964. All fish captured at the Bear Creek weir were examined for marks. Of the 953 enumerated, 436 (45.8 percent) were marked (AD-LV). The temporal distribution of marked and unmarked fish was nearly equal throughout the migration. The great number of unmarked fish is not completely understood at this time. It is believed that most of the 1963 smolt out-migration was sampled because the peak of the migration occurred on June 7 and the Wolf-trap was operated continuously from May 11 to June 30. The large number of unmarked fish is possibly due to the following: (1) adults straying from other nearby streams, (2) a high differential survival between marked and unmarked fish, and (3) an extensive later seaward migration after the normal June migration.

The survival of marked smolts to returning adults in Bear Creek (marine survival) was 6.13 percent ($436/7,111 \times 100$). The marine survival of the 1963 run in Bear Creek was calculated at 1.72 percent.

The rate of exploitation (Ricker, 1958) of the total fishery in Resurrection Bay was determined by sampling the sport catch throughout the season as frequently as possible concomitant with the creel census. The commercial fishery was not sampled because the March 27 earthquake had destroyed the canneries and the catches were not readily accessible.

A total of 630 fish was examined of which 27 (4.29 percent) were marked. The percentage of marked fish, expanded for the estimated total catch of 3,627, yielded an estimated 155 marked silver salmon taken. The estimated rate of exploitation was 2.18 percent ($155/7,111 \times 100$). This is lower than the 1963 estimate of 2.64 percent. The marked fish catch-to-escapement ratio was 0.4:1 (155/436). This is considerably lower than the 1963 estimate of 1.5:1. Precocious males, because of their scarcity, were not considered in the above estimates.

Spawning Channel Water Supply Evaluation

Good silver salmon spawning area in the tributaries of Bear Lake is limited. Should the rehabilitation of Bear Lake prove successful in markedly increasing its rearing capacity for juvenile silver salmon, shortage of good spawning area could become a serious problem. Because of this, the feasibility of constructing a small artificial spawning channel on one of the lake's inlets is being investigated. Inlet No. 3 at the south end of the lake, on U.S. Forest Service land, is the only stream where the adjacent topography is flat enough for channel construction. A small weir to measure water flows was established on October 5 about 300 yards from the lake and at a point 50 yards below the point where the stream emerges from a steep gorge. The stream disappeared into the ground about 100 yards from the lake during November. When this occurred, eight silver salmon were stranded and died without spawning.

Water chemistry on March 3, 1965 was as follows: dissolved oxygen - 12 ppm, pH - 7.6 and methyl orange alkalinity - 62 ppm. The highest recorded stream flow was 12.9 cfs on October 23 and the lowest was 1.9 cfs on December 21 and February 25. Water temperatures ranged from 45 to 32° F. and air temperatures from 53 to -11° F. The maximum recorded snow depth was 34 inches. Stream flows, temperatures and snow depths by monthly periods are presented in Table 10.

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1960. Silver Salmon Studies in the Resurrection Bay Area. Alaska Department of Fish and Game Dingell-Johnson Annual Report of Progress, 1960-1961, Vol. 2, pp. 289-303.

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TABLE 10. - Monthly Stream Flows (cfs), Snow Depths (inches), Water and Air Temperatures (° F.) at Inlet No. 3 of Bear Lake During the Winter of 1964-1965

Period	Number of Observations	Stream Flow		Water Temp.		Air Temperature Range	Snow Depth
		Mean	Range	Mean	Range		
10/ 5-10/27	5	8.3	6.0-12.9*	38.4	45-35	53-22	0-1
11/ 2-11/ 9	3	4.0	3.7- 4.4	35.3	37-34	40-20	7-12
12/ 8-12/31	4	2.3	1.9- 2.9	32.3	33-32	43-(-11)	18-21
1/ 9- 1/28	4	2.3	2.1- 2.5	32.3	33-32	36-(-2)	21-22
2/11- 2/25	3	2.1	1.9- 2.2	33.0	34-32	36-1	30-34

* Flow weir washed out because of high stream flows on 10/12.

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The marking (fin clipping) of silver salmon smolts provides the biologist with known population data for determining marine survival.